Mixed integer linear programming constrained optimization problem: Manufacturing Problem

Reference:

Book Title: Higher Engineering Mathematics

Author(s): B.S. Grewal
Edition : 43rd Edition 2015

Problem:

A firm making castings uses electric furnace to melt iron with the following:

Material	Carbon (%)	Silicon (%)	Cost(Rupees)
Steel Scrap	0.4	0.15	850/tonne
Cast Iron Scrap	3.8	2.40	900/tonne
Remelt from foundry	3.5	2.30	500/tonne

Carbon (min=3.2%, max=3.4%), Silicon (min=2.25%, max =2.35%)

If the total charge of iron metal required is 4 tonnes, find the weight in kg of each raw material that can be used in the optimal mix of minimum cost.

Mathematical Formulation:

Let x1, x2, x3 be the amounts (in kg) of these raw materials. The objective is to minimize the cost of the raw material:

Z= (850/1000) x1 + (900/1000) x2 + (500/1000) x3

For iron melt to have a minimum of 3.2% of carbon,

0.4x1 + 3.8x2 + 3.5x3 >= 3.2*4.00

For iron melt to have a minimum of 2.25 % of silicon,

0.15x1 + 2.40 x2 + 2.30x3 >= 2.25*4.00

How to use the code:

- The user needs to enter the number of variables. It is **3** in the problem chosen above.

- Now, the user has to enter the coefficients of the variables when asked. The values to be stored in the vector here are **0.85, 0.85, 0.9, and 0.5.**
- Now, the user is asked to enter the number of inequality constraints which is **4** in this case. Now, the user is asked to enter the value of all inequality constraints in following steps.
- Now, enter the coefficient of the variables for 1.0 constraint. Here, these are **-0.4, -3.8,-3.5.**
- Enter the coefficient of the variables for 2.0 constraints. The values to be entered for above problem are **0.4, 3.8, and 3.5.**
- Enter the coefficient of the variables for 3.0 constraints which are **-0.15, -2.41, and -2.35.**
- Enter the coefficient of the variables for 4.0 constraints. Here, the values are **0.15, 2.41, and 2.35**.
- Enter the right side of the inequalities. The values of variables in the equality constraints are **12800, 13600, 9000, 9400**
- Enter the number of equality constraint. There is only **one** equality constraint.
- Enter the coefficient of the variables for 1.0 constraint which are **1, 1, and 1** for the problem stated above.
- Enter the right side of the equalities. That is **4000** as mentioned in the problem.

Function to be used:

xopt = intlinprog(c,intcon,A,b,Aeq,beq,lb,ub,options)

c:
a vector of double, contains coefficients of the variables in the objective
intcon :
Vector of integer constraints, specified as a vector of positive integers. The values in intcon indicate the components of the decision variable x that are integer-valued. intcon has values from 1 through number of variable.
A :
A matrix of doubles, containing the coefficients of linear inequality constraints of size (m X n) where 'm' is the number of linear inequality constraints.
b :
A vector of doubles, related to 'A' and containing the the Right hand side equation of the linear inequality constraints of size (m X 1).
Aeq :
A matrix of doubles, containing the coefficients of linear equality constraints of size (m1 X n) where 'm1' is the number of linear equality constraints.
beq :
A vector of doubles, related to 'Aeq' and containing the the Right hand side equation of the linear equality constraints of size (m1 X 1).
lb :
A vector of doubles, containing the lower bounds of the variables of size (1 X n) or (n X 1) where 'n' is the number of variables.
ub :

A vector of doubles, containing the upper bounds of the variables of size (1 X n) or (n X 1) where 'n' is the number of variables.